CLAIMS

That which is claimed is:

1. A system for stabilizing tissue comprising:

a tissue contact member having a surface adapted to contact the tissue and temporarily maintain the tissue in a relatively immobilized state; and

a maneuverable arm attached to said tissue contact member, said maneuverable arm including an articulating joint formed by a link having a male articulating surface composed of angled teeth and a female articulating surface having angled trenches adapted to receive said angled teeth, wherein said articulating joint moves in one degree of freedom directed by said angled teeth sliding against said angled trenches.

2. The system of claim 1, wherein said maneuverable arm comprises a plurality of said articulating joints.

3. The system of claim 1, further comprising a rotational joint formed by a link having a male articulating surface and a link having a female articulating surface, said male and female articulating surfaces being positioned for relative rotation in a plane perpendicular to a longitudinal axis of said maneuverable arm.

4. The system of claim 3, wherein said maneuverable arm comprises at least two of said articulating joints, at least one of said articulating joints being positioned adjacent each side of said rotational joint.

5. The system of claim 4, wherein said rotational joint comprises a first rotational joint and said tissue contact member is attached to a distal end of said maneuverable arm, said maneuverable arm further comprising a second rotational joint distally positioned adjacent said at least one articulating joint positioned adjacent a distal side of said first rotational joint.

6. The system of claim 4, further comprising a plurality of said articulating joints positioned on each side of said rotational joint.

7. The system of claim 6, wherein each said articulating joint is rotatable in a plane perpendicular to said plane of rotation of said rotational joint.

8. The system of claim 5, wherein said second rotational joint is formed by a component have a male articulating surface and a component having a female articulating surface, said male and female articulating surfaces being positioned for relative rotation in a plane perpendicular to a longitudinal axis of said maneuverable arm.

9. The system of claim 8, wherein one of said components is a link having an articulating surface at an end opposite to said rotational joint articulating surface which is composed of angled teeth or angled trenches for articulating with a link distally adjacent said component, and wherein the other of said components comprises a mount adapted to mount said system to a fixed object.

10. The system of claim 9, wherein said mount comprises a first mount portion integral with one of said male and female articulating surfaces of said second rotational joint, and a second mount portion attached to a proximal side of said first mount portion.

11. The system of claim 10, wherein said second mount portion is pivotally attached to said first mount portion, and is pivotable away from said first mount portion to position the mount over a fixed object, or release the mount from the fixed object.

12. The system of claim 10, wherein said second mount portion is pivotable toward said first mount portion to fix said mount on the fixed object.

13. The system of claim 12, wherein said mount further comprises a locking mechanism adapted to lock said second mount portion to said first mount portion in a closed position upon pivoting said second mount portion toward said first mount portion, said closed position being configured to lock said mount on said fixed object.

14. The system of claim 13, wherein said fixed object is a sternal retractor.

15. The system of claim 14, wherein said first and second mount portions each further comprise a rail grip adapted to engage one side of a rail on said sternal retractor.

16. The system of claim 13, wherein said locking mechanism comprises a living hinge formed in one of said first and second mount portions and a pin extending transversely on the other of said first and second mount portions, said pin being adapted to snap fit into said living hinge.

17. The system of claim 10, further comprising a cable passing internally through each of said articulating joints, rotational joints and mount, said cable being further attached to a tensioning mechanism proximally of said mount.

18. The system of claim 17, wherein said tensioning mechanism comprises a screw mechanism and a knob, said screw mechanism having a first threaded component having a first set of threads and a second threaded component having a second set of threads adapted to mate with said first set of threads, said first threaded component being fixed to said cable and said knob being adapted to torque said second threaded component with respect to said first threaded component.

19. The system of claim 18, wherein said second threaded component comprises a torque limiter.

20. The system of claim 19, wherein said torque limiter further comprises a unidirectional slip clutch engaging said knob, wherein said knob positively engages said torque member for unthreading said second set of threads from said first set of threads, and positively engages said torque limiter for threading said second set of threads on said first set of threads until a predetermined amount of torque is required to further tension said cable.

21. The system of claim 20, wherein, upon reaching said predetermined amount of torque during threading, said torque limiter slips with respect to said knob.

22. The system of claim 20, wherein said slip clutch comprises at least one fin extending from an outer surface of said second threaded member at an angle to a line normal to a tangent line passing through the location from which said fin extends, each said fin adapted to engage a groove formed in an inner surface of said knob.

23. The system of claim 17, wherein said cable comprises a stop member fixed to a distal end of said cable, wherein, upon applying tension to said cable with said tensioning member, said stop member and said tensioning member apply a compressive force to said articulating joints and rotational joints, thereby locking every joint into an assumed orientation.

24. The system of claim 17, wherein said cable comprises a stop member fixed to a distal end of said cable and adapted to apply a compressive force to a distal end of said maneuverable arm when said cable is placed under tension.

25. The system of claim 24, further comprising a coupling mechanism linking said stop member to said tissue contact member, said coupling member adapted to lock said tissue contact member in an assumed position when said cable is placed under tension.

26. The system of claim 25, wherein said coupling mechanism includes a ball member fixed to said tissue contact member and a socket member rotatably joined with said stop member and adapted to receive said ball member to form a ball joint.

27. The system of claim 25, wherein said socket member includes a slot through a side wall thereof, said slot terminating in an enlarged opening dimensioned to permit said ball member to pass therethrough.

28. The system of claim 26, wherein said coupling mechanism further comprises a coupling link having arms adapted to lock with said socket member, and an upper abutment surface adapted to abut said stop member.

29. The system of claim 28, wherein said coupling link is a first coupling link and said coupling mechanism further comprises a second coupling link having driving surfaces adapted to contact a distal most link of a distal most articulating joint of said maneuverable arm, said second coupling link further including a lower abutment surface adapted to abut an upper portion of said ball member, wherein, upon tensioning of said cable, said stop member draws said first coupling link and said socket member in a proximal direction, whereby said socket member compresses said ball member against said lower abutment surface.

30. The system of claim 17, further comprising a flexible sleeve positioned over said articulating joints and said rotational joints.

31. The system of claim 30, wherein said flexible sleeve comprises an elastomer.

32. The system of claim 30, wherein said flexible sleeve comprises silicone or dip molded PVC.

33. The system of claim 30, wherein said flexible sleeve comprises a material having a four or six way stretch.

34. The system of claim 33, wherein said flexible sleeve comprises LYCRA or SPANDEX.

35. The system of claim 1, wherein said maneuverable arm is rotationally attached, at a distal end thereof to said tissue contact member.

36. The system of claim 35, wherein said tissue contact member is rotatable in three degrees of freedom with respect to said distal end of said maneuverable arm.

37. The system of claim 36, further comprising a locking mechanism for locking said tissue contact member with respect to said maneuverable arm in virtually any position to which said tissue contact member may be maneuvered when in an unlocked state.

38. The system of claim 37, wherein said locking mechanism simultaneously locks said maneuverable arm in virtually any position to which said maneuverable arm may be maneuvered when in an unlocked state.

39. The system of claim 1, wherein said tissue contact member comprises a pair of feet extending substantially parallel to one another and adapted to straddle a target site on the tissue.

40. The system of claim 39, wherein said pair of feet extend from a common base portion, said common base portion being angled away from a plane in which said feet substantially extend.

41. The system of claim 39, further comprising a ball member linked to said common base portion with a post, said ball member being adapted to form a ball joint at said distal end of said maneuverable arm.

42. The system of claim 39, wherein each of said feet has a frictional surface adapted to contact the tissue.

43. The system of claim 39, wherein each said foot comprises a thin compliant seal extending around a perimeter of a bottom surface of the respective foot.

44. The system of claim 43, wherein each said compliant seal has a tapering thickness, wherein said thickness is greater adjacent said bottom surface of said foot and tapers thinner in a direction extending away from said bottom surface.

45. The system of claim 43, wherein each said foot has a proximal end and a distal end and each said seal has a tapering length, said length measuring a distance that said seal extends away from said bottom surface of the respective foot.

46. The system of claim 45, wherein said length of each said seal is greater near said proximal end of said foot than near said distal end of said foot.

47. The system of claim 43, wherein each said seal comprises SOFTFLEX.

48. The system of claim 39, wherein said tissue contact member further comprises a manifold base interconnected with said pair of feet, said manifold base being substantially hollow and having a pair of fittings extending therefrom, said feet being mounted on said fittings.

49. The system of claim 48, wherein each fitting has an opening therethrough which fluidly connects said respective foot with said manifold base.

50. The system of claim 48, wherein each said foot is independently rotatable about said respective fitting.

51. The system of claim 49, wherein each said foot has a hollow interior defining a vacuum chamber, each said vacuum chamber having a first opening adapted to engage at least a portion of said tissue and a second opening fluidly coupled with said opening through said respective fitting.

52. The system of claim 51, wherein said vacuum chamber further comprises channels formed on an upper interior surface of each said foot.

53. The system of claim 52, wherein said channels are aligned substantially parallel to one another and extend in a direction from said proximal end to said distal end of said foot.

54. The system of claim 53, further comprising a deep channel near said distal end of each said foot, said deep channel fluidly communicating with said opening through said fitting, respectively.

55. The system of claim 53, wherein each said foot comprises a thin compliant seal extending around a perimeter of a bottom surface of the respective foot and integrally molded in a pair of said channels nearest said perimeter.

56. The system of claim 48, wherein each said foot has an asymmetrical transverse cross-section, a portion of said cross-section further from the other of said feet being thicker than a portion nearer to the other of said feet, to provide more available space between said feet.

57. The system of claim 53, further comprising a porous filter covering at least a portion of said channels

58. The system of claim 57, wherein each said foot comprises a thin compliant seal extending around a perimeter of a bottom surface of the respective foot and said porous filter is integrally molded with said thin compliant seal, respectively.

59. The system of claim 55, wherein each said seal is provided with one or more grooves to further enhance the flexibility of said seal.

60. The system of claim 49, wherein each said fitting has an enlarged lip and said feet are adapted to snap fit over said enlarged lips, thereby substantially sealing said feet with said fittings without the need for an O-ring or other additional sealing member therebetween.

61. The system of claim 48, further comprising a third fitting extending from said manifold base, said third fitting an opening therethrough which is adapted to connect said manifold base with a vacuum source.

62. The system of claim 61, further comprising a rotatable fitting adapted to snap fit over said third fitting, said rotatable fitting further comprising an inlet tube configured for connecting with a vacuum line, whereby the vacuum line is rotatably mounted to said manifold base.

63. The system of claim 39, wherein said pair of feet extend from a common base portion, and a ball member is linked to said common base portion with a post, said ball member being adapted to form a ball joint at said distal end of said maneuverable arm.

64. The system of claim 63, wherein each of said pair of feet comprises an extremely low profile structural member and a thin compliant seal extending from a bottom perimeter of said structural member.

65. The system of claim 64, wherein each said thin compliant seal comprises a vacuum inlet adapted to connect with a vacuum line.

66. The system of claim 64, wherein said extremely low profile structural member is formed from a sheet of stainless steel.

67. A maneuverable arm adapted to position a surgical tool mounted at a distal end thereof in a variety of orientations, said maneuverable arm comprising:

at least one articulating joint formed by a link having a male articulating surface composed of angled teeth and a female articulating surface having angled trenches adapted to receive said angled teeth, wherein said articulating joint moves in one degree of freedom directed by said angled teeth sliding against said angled trenches.

68. The maneuverable arm of claim 67, wherein said trenches have an aspect ratio of at least about 1:2.

69. The maneuverable arm of claim 68, wherein said aspect ration of said trenches is about 1:1.

70. The maneuverable arm of claim 67, wherein said teeth have an aspect ratio of at least about 1:2.

71. The maneuverable arm of claim 70, wherein said aspect ration of said teeth is about 1:1.

72. The maneuverable arm of claim 67, wherein said at least one articulating joint comprises a plurality of said articulating joints.

73. The maneuverable arm of claim 72, further comprising a cable extending internally through each of said articulating joints, said cable having a stop member at a distal end thereof, said maneuverable arm further comprising an anchor fixed to a proximal end of said cable, wherein each of said articulating joints are sequentially held together in approximation by said cable, stop member and anchor.

74. The maneuverable arm of claim 73, further comprising a mount adjacent a proximal most of said articulating joints, said cable passing through said mount and said mount being approximated with said articulating joints by said anchor.

75. The maneuverable arm of claim 73, further comprising a rotational joint formed by a link having a male articulating surface and a link having a female articulating surface, said male and female articulating surfaces being positioned for relative rotation in a plane perpendicular to a longitudinal axis of said maneuverable arm.

76. The maneuverable arm of claim 75, wherein said rotational joint is positioned between a pair of said articulating joints.

77. The maneuverable arm of claim 76, wherein said link of said rotational joint having a male articulating surface has an articulating surface at an opposite end thereof which comprises trenches or teeth for articulating with said adjacent articulating joint, and wherein said

link of said rotational joint having a female articulating surface has an articulating surface at an opposite end thereof which comprises trenches or teeth for articulating with said adjacent articulating joint.

78. The maneuverable arm of claim 75, wherein said rotational joint is positioned as an end joint of said maneuverable arm.

79. The maneuverable arm of claim 74, further comprising a rotational joint formed by a link having a male articulating surface and a link having a female articulating surface, said male and female articulating surfaces being positioned for relative rotation in a plane perpendicular to a longitudinal axis of said maneuverable arm.

80. The maneuverable arm of claim 79, wherein said rotational joint is positioned between a pair of said articulating joints.

81. The maneuverable arm of claim 80, wherein said link of said rotational joint having a male articulating surface has an articulating surface at an opposite end thereof which comprises trenches or teeth for articulating with said adjacent articulating joint, and wherein said link of said rotational joint having a female articulating surface has an articulating surface at an opposite end thereof which comprises trenches or teeth for articulating with said adjacent articulating joint.

82. The maneuverable arm of claim 79, wherein said rotational joint is positioned between a proximal most one of said articulating links and said mount, and wherein said male or female articulating surface of said rotational joint is integral with said mount.

83. The maneuverable arm of claim 82, wherein said male articulating surface of said rotational joint is integral with said mount.

84. The maneuverable arm of claim 79, wherein said rotational joint is positioned as an end joint of said maneuverable arm.

85. The system of claim 74, wherein said mount comprises a first mount portion adjacent said proximal most of said articulating joints, and a second mount portion attached to a proximal side of said first mount portion.

86. The system of claim 85, wherein said second mount portion is pivotally attached to said first mount portion, and is pivotable away from said first mount portion to position the mount over a fixed object, or release the mount from the fixed object.

87. The system of claim 85, wherein said second mount portion is pivotable toward said first mount positioned to fix said mount on the fixed object.

88. The system of claim 87, wherein said mount further comprises a locking mechanism adapted to lock said second mount portion to said first mount portion in a closed position upon pivoting said second mount portion toward said first mount portion, said closed position being configured to lock said mount on said fixed object.

89. The system of claim 88, wherein said fixed object is a sternal retractor.

90. The system of claim 89, wherein said first and second mount portions each further comprise a rail grip adapted to engage one side of a rail on said sternal retractor.

91. The system of claim 88, wherein said locking mechanism comprises a living hinge formed in one of said first and second mount portions and a pin extending transversely on the other of said first and second mount portions, said pin being adapted to snap fit into said living hinge.

92. The system of claim 74, further comprising a tensioning mechanism connected proximally of said mount, wherein said tensioning mechanism comprises a screw mechanism and a knob, said screw mechanism having a first threaded component having a first set of threads and a second threaded component having a second set of threads adapted to mate with said first

set of threads, said first threaded component being fixed to said cable and said knob being adapted to torque said second threaded component with respect to said first threaded component.

93. The system of claim 92, wherein said second threaded component comprises a torque limiter.

94. The system of claim 93, wherein said torque limiter further comprises a unidirectional slip clutch engaging said knob, wherein said knob positively engages said torque member for unthreading said second set of threads from said first set of threads, and positively engages said torque limiter for threading said second set of threads on said first set of threads until a predetermined amount of torque is required to further tension said cable.

95. The system of claim 94, wherein, upon reaching said predetermined amount of torque during threading, said torque limiter slips with respect to said knob.

96. The system of claim 94, wherein said slip clutch comprises at least one fin extending from an outer surface of said second threaded member at an angle to a line normal to a tangent line passing through the location from which said fin extends, each said fin adapted to engage a groove formed in an inner surface of said knob.

97. The system of claim 92, wherein, upon applying tension to said cable with said tensioning member, said stop member and said tensioning member apply a compressive force to said maneuverable arm, thereby locking every joint into an assumed orientation.

98. A tensioning mechanism for applying tension to a cable passing through a maneuverable surgical instrument having at least one articulating joint through which the cable passes, said tensioning mechanism comprising a screw mechanism and a knob, said screw mechanism having a first threaded component having a first set of threads and a second threaded component having a second set of threads adapted to mate with said first set of threads, said first threaded component being fixed to said cable and said knob being adapted to torque said second threaded component with respect to said first threaded component.

99. The mechanism of claim 98, wherein said second threaded component comprises a torque limiter.

100. The mechanism of claim 98, wherein said torque limiter further comprises a unidirectional slip clutch engaging said knob, wherein said knob positively engages said torque member for unthreading said second set of threads from said first set of threads, and positively engages said torque limiter for threading said second set of threads on said first set of threads until a predetermined amount of torque is required to further tension said cable.

101. The mechanism of claim 100, wherein, upon reaching said predetermined amount of torque during threading, said torque limiter slips with respect to said knob.

102. The mechanism of claim 100, wherein said slip clutch comprises at least one fin extending from an outer surface of said second threaded member at an angle to a line normal to a tangent line passing through the location from which said fin extends, each said fin adapted to engage a groove formed in an inner surface of said knob.

103. The mechanism of claim 98, wherein, upon torquing said second threaded component with respect to said first threaded component, said cable is drawn under tension.

104. A device for stabilizing tissue within a patient's body comprising:

a manifold base having a substantially hollow interior adapted to be develop a negative pressure therein;

at least one tissue contact member extending outwardly from said manifold base and being fluidly connected therewith, each of said at least one tissue contact having a thin compliant seal extending around a perimeter of a bottom surface of the contact member.

105. The device of claim 104, wherein each said tissue contact member is rotatable with respect to said manifold base.

106. The device of claim 105, wherein each said tissue contact member is independently rotatable with respect to said manifold base.

107. The device of claim 104, wherein each said tissue contact member has a hollow interior defining a vacuum chamber, each said vacuum chamber having a first opening adapted to engage at least a portion of the tissue and a second opening fluidly coupled with said manifold base.

108. The device of claim 104, wherein said manifold base comprises a fitting extending therefrom for each respective tissue contact member, each said fitting having an opening therethrough to fluidly connect said respective tissue contact member to said manifold base.

109. The device of claim 108, wherein each said fitting has an enlarged lip and said tissue contact members are adapted to snap fit over said enlarged lips, thereby substantially sealing said tissue contact members with said fittings without the need for an O-ring or other additional sealing member therebetween.

110. The device of claim 107, wherein each said vacuum chamber further comprises channels formed on an upper interior surface of each said tissue contact member.

111. The device of claim 110, wherein said channels are aligned substantially parallel to one another and extend in a direction from said proximal end to said distal end of said tissue contact member.

112. The device of claim 111, further comprising a deep channel near said distal end of each said tissue contact member, each said deep channel fluidly communicating with said manifold base.

113. The device of claim 104, wherein said at least one tissue contact member comprises a pair of tissue contact members extending substantially parallel to one another from said manifold base.

114. The device of claim 104, wherein each said compliant seal has a tapering thickness, wherein said thickness is greater adjacent said bottom surface of said tissue contact member and tapers thinner in a direction extending away from said bottom surface.

115. The device of claim 104, wherein each said tissue contact member has a proximal end and a distal end and each said seal has a tapering length, said length measuring a distance that said seal extends away from said bottom surface of the respective tissue contact member.

116. The device of claim 115, wherein said length of each said seal is greater near said proximal end of said tissue contact member than near said distal end of said tissue contact member.

117. The system of claim 104, wherein each said seal comprises SOFTFLEX.

118. The device of claim 104, wherein each said tissue contact member has an asymmetrical transverse cross-section, a portion of said cross-section contemplated to be further from a target site on the tissue being thicker than a portion contemplated to be nearer to the target site, to provide rigidity to the tissue contact member as well as more available space near the target site.

119. The device of claim 110, further comprising a porous filter covering at least a portion of said channels.

120. The device of claim 119, each said porous filter is integrally molded with each said thin compliant seal, respectively.

121. The device of claim 104, wherein each said seal is provided with one or more grooves to further enhance the flexibility of said seal.

122. The device of claim 104, further comprising a vacuum inlet mounted to said manifold base, wherein said vacuum inlet is rotatable with respect to said manifold base.

123. The device of claim 122, wherein said vacuum extends from a rotatable fitting adapted to snap fit over a vacuum inlet fitting extending from said manifold base, said rotatable fitting being rotatable with respect to said manifold base and said vacuum inlet being configured for connecting with a vacuum line.

124. The device of claim 104, further comprising a post having a distal end and a proximal end, said distal end connected to said manifold base and said proximal end terminated in a ball-shaped member.

125. The device of claim 104, wherein each said tissue contact member comprises an extremely low profile structural member and a thin compliant seal extending from a bottom perimeter of said structural member.

126. The device of claim 125, wherein each said thin compliant seal comprises a vacuum inlet adapted to connect with a vacuum line.

127. The device of claim 125, wherein said extremely low profile structural member is formed from a sheet of stainless steel.

128. A device for providing additional stabilization to tissue already in contact with a primary stabilization member, said device comprising:

at least one tissue contact member adapted to be placed on the tissue in an area bounded by primary tissue contact members; and

a connecting member extending from said at least one tissue contact member and adapted to be hand held or fixed to a relatively immovable object.

129. The device of claim 128, wherein said at least one tissue contact member comprises a base member having a central opening therethrough, said central opening adapted to allow access to a target site on the tissue.

130. The device of claim 129, wherein said base member is substantially oval-shaped.

131. The device of claim 130, wherein said oval-shaped member cants upwardly around an outer perimeter thereof in the shape of a cowboy hat.

132. The device of claim 129, wherein said base member has a substantially hollow interior adapted to develop a negative pressure therein.

133. The device of claim 132, wherein said connecting member fluidly connects with said substantially hollow interior and is adapted to be connected to a source of negative pressure.

134. The device of claim 132, wherein said base member further comprises openings through a bottom surface thereof, said openings being fluidly connected with said substantially hollow interior and adapted to apply a negative pressure to the tissue.

135. The device of claim 134, wherein said base member further comprises openings through an upper surface thereof, said openings through said upper surface being fluidly connected with a lumen that is connectable with a source of pressure that is independent of a pressure in said substantially hollow interior of said base member.

136. The device of claim 135, wherein said lumen runs inside of said connecting member.

137. The device of claim 135, further comprising a manifold mounted inside said base member and fluidly connecting said lumen with said openings through said upper surface.

138. A system for stabilizing tissue within a patient's body comprising:

a primary tissue contact member having at least a pair of primary contact members adapted to contact the tissue and straddle a target site thereon;

a primary connecting member extending from said primary tissue contact member, said connecting member adapted to be fixed to a relatively stationary object to impart added stability to said primary tissue contact member;

a secondary tissue contact member adapted to be placed on the tissue in an area straddled by said primary contact members; and

a secondary connecting member extending from said secondary tissue contact member and adapted to be hand held or fixed to a relatively immovable object.

139. A method of stabilizing tissue at a location of a target site at which an operative procedure is to be performed, while tissue outside of the location remains in motion, said method comprising:

contacting the tissue in the vicinity of the location with a primary stabilizing instrument to stabilize the general vicinity of the location; and

contacting the tissue in a location between the location where the primary stabilizing instrument contacts the tissue and the target site, to further stabilize the target site.

140. The method of claim 139, further comprising fixing said primary stabilizing instrument to a relatively immovable object after said contacting the tissue.

141. The method of claim 140, further comprising fixing said secondary stabilizing instrument to a relatively immovable object after said contacting the tissue therewith.

142. The method of claim 141, wherein said primary and secondary stabilizing instruments are both fixed to a sternal retractor.

143. The method of claim 140, further comprising fixing said secondary stabilizing instrument to said primary stabilizing instrument after said fixing the primary stabilizing instrument and said contacting the tissue with the secondary stabilizing instrument.

144. The method of claim 140, further comprising fixing said secondary stabilizing instrument by hand holding the secondary stabilizing instrument.

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